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(54) BRAKE DISC FOR USE IN A DISC BRAKE ASSEMBLY

(71) We, KNORR-BREMSE GmbH, 8 Munich 40, Moosacher Strasse 80, Germany (Fed. Rep.) and a German company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a brake disc of the type suitable for use in a disc brake assembly, said brake disc comprising a friction ring formed by a pair of annular friction surfaces which are axially spaced and which extend in radial planes; and in which said brake disc has radially extending cooling ducts, provided in the space between the friction surfaces, and the brake disc being so arranged that, in use, a substantially similar cooling effect is produced for the brake disc for either direction of rotation of the brake disc. A brake disc of the above type will be referred to hereinafter as being "of the type specified".

Known brake discs of the type specified have, in the friction ring between two outwardly extending friction faces, cooling air ducts extending from the hub interior towards the periphery. Venting of these numerous ducts is effected due to the air stream set up on rotation of the disc from the interior towards the exterior.

Since the braking power which can be taken up by the brake disc during a braking operation, for braking the speed of a vehicle, must not exceed a pre-determined degree due to the restricted permissible heating of the brake disc, amplification of the power take-up, i.e. increased braking power, is a function inter alia of the increase in the heat discharge at the brake disc. Thus, to the extent that it is found to be possible to improve heat discharge, higher braking powers or braking capacities, such as occur to an increasing extent in disc brake devices because of high rail vehicle velocities and braking procedures occuring chronologically closely one upon the other, can be taken up by the brake disc without exceeding permissible temperatures.

The invention has been developed primarily, though not exclusively, to achieve an increase in the heat discharge in brake discs of the type specified whilst, at the same time, the constructional means employed for that purpose are, utilising spatial conditions, relatively inexpensively, and in such manner as to require only small constructional outlay, to afford as far as possible an optimum with regard to increase in the existing air throughout.

According to the invention there is provided a brake disc of the type specified, comprising a chamber defined radially inwardly of said cooling ducts, and a radial-flow fan provided in said chamber for rotation with the friction ring; in which the fan has radial blades and is arranged to receive an inflow of cooling air in a direction generally parallel to the axis of the fan, and communicates with said ducts to supply the cooling air radially outwardly to said ducts.

Embodiments of brake disc according to the invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a sectional view of a brake disc according to the invention, attached to one side of a rail vehicle wheel;

Figure 2 is a plan view of a portion of the brake disc shown in Figure 1;

Figure 3 is a cross-sectional view taken on the line II—II in Figure 2;

Figure 4 is a view, similar to Figure 1, of an alternative construction of brake disc; and

Figure 5 is a view, similar to Figures 1 and 4, of a further alternative construction of brake disc.

Disposed on a shaft 1 (Figure 1) is a hub 2 of a wheel (not shown) (which hub forms part of the disc). Attached at the end face 3 of the hub is a brake disc carrier ring 4 supporting a friction ring 5 formed with a plurality of cooling air ducts 6. An inner chamber 7 is defined by the carrier ring 4 and one end of the shaft 1, and a radial-flow fan wheel 8 is arranged countersunk in the carrier ring 4, in the chamber 7.

The radial-flow fan wheel 8 (Figure 3) has a carrier or support ring 9 which has an outer surface 10 comprising a concavely arcuate profile which has a section 14 extending generally parallel to the rotation axis 13 and the direction of inflow of cooling air on the suctional intake side 12 and on the side remote from the suctional intake side, a substantially radially outwardly extending section 15. From the one into the other section there is an arrangement for flowing transition the purpose of which it is to prevent to the maximum extent the setting up of turbulent flows in the suctional intake air stream. Arranged uniformly distributed on the carrier or support ring 9 is a plurality of blades 17, secured for example by welding. Whereas the blades 17, on the suctional intake side 12, have their roots extending along the sections 14 and axially at maximum as far as the frictional face 19 remote from the vehicle wheel hub, the blades 17 extend, on their blow-off side or discharge end 20, to a location directly upstream of or adjacent to radially internally located flow-in apertures 21 of the cooling air ducts 6. On the hub-side, the design of the fan 8 is a function of constructional and assembly-conditioned circumstances. For achieving flow-advantageous conditions, the aperture of the chamber or internal passage 22 surrounded by the carrier ring 9 is covered by a cap 23, the outer face 25 thereof merging smoothly into the generated surface 10 of the carrier ring 9.

Instead of the design just described, of the radial fan wheel 8 as a loose, attachable individual element, it is possible to form the blade 17, and the surface on which it is provided i.e. the profile generated surface 10, directly on elements of the brake disc or on the friction ring.

The requirement that it should be possible to drive the friction disc in both directions of rotation, without thereby setting up varying cooling air streams which are a function of direction of rotation, produces the result that it is not permissible to impart to the blades 17 an angle of incidence or attack which is related to only one direction of rotation. However, it is quite readily possible to impart to the blades 17 on both sides, in each particular instance, a surface which related to their axis-parallel central plane 27 extend completely symmetrically and which also exhibits an angle of incidence. With this arrangement, both surfaces of the blades 17 can, with reference to their central plane 27 located in the axial direction, be provided with a surface 29 extending linearly or non-linearly and/or which is a surface extending with variably curved configuration, radially from the interior outwardly. The surfaces 29 of both blade sides include an acute angle diverging towards the suctional intake side 12.

Finally, reference will also be made to further examples of embodiments of the invention, whereby there is imparted to the blades, in relatively simple manner, an angle of incidence adapted to be associated in each particular instance to correspond to the particular direction of rotation which obtains. In this case, the blades are not rigidly attached at their internally located delimiting edge (Figure 4) to the generated surface 10 of the carrier ring 9. Due to relatively loose retaining of the blade body 17, the result is achieved that the blade automatically adopts, due to the incident flow of air, a position possessing an angle of incidence, whereby influence is exerted on the suctional intake air quantity.

With this arrangement, the retaining system can be of varying design. One possibility for a retaining system consists (Figure 5) in retaining each blade 17 to be tiltable about a substantially radially extending axis 36 which, however, is axially spaced from the suctional intake side 12. The axis 36 is positioned so that the axis adopts a position such that under the influence of an incident flow acting on the faces of the blade 17, due to rotation of the brake disc, a tilting moment automatically setting up the angle of incidence 33, 34 remains. Devices for limiting this pivoting movement of the blades to a few degrees of angle of incidence can be provided, in optional manner, by means of stops 38.

The blades 17 can also be articulated for pivoting about a radially extending axis or pivot 31 (Figure 4) near the intake side 12, and with this system the angle of incidence which is limited to only a few degrees is delimited by appropriately arranged stops 38 on both sides of the blades 17 on the generated surface 10.

In the case of a further embodiment (not shown) of the invention, an active pivoting or tilting movement of the blades is achieved due to the use of a drag plate responding to both directions of rotation.

WHAT WE CLAIM IS:—

1. A brake disc of the type specified, comprising a chamber defined radially inwardly of said cooling ducts, and a radial-flow fan provided in said chamber for rotation with the friction ring; in which the fan has radial blades and is arranged to receive an inflow of cooling air in a direction generally parallel to the axis of the fan, and communicates with said ducts to supply the cooling air radially outwardly to said ducts.

2. A brake disc according to claim 1, in which the root of each blade extends generally parallel to said axis.

3. A brake disc according to claim 1 or 2, including a wheel hub secured to the friction ring, the latter extending axially therefrom so as to define said chamber; and in which the fan is arranged, counter sunk, in said chamber.

4. A brake disc according to claim 3, in which a carrier ring is connected to the wheel hub, and the roots of the blades of the fan are supported by said carrier ring; the roots of the blades extend axially in a direction away from the wheel hub, at the most, up to the axial position of one of the two annular friction surfaces which is remote from the wheel hub; and the blades extend radially outwardly to locations directly adjacent to inlet apertures to said cooling ducts.

5. A brake disc according to claim 4, in which the carrier ring has a radially outer surface which is in two portions, a first portion being concave (radially outwardly) and extending generally parallel to the axis of the fan towards an air intake to the fan, and a second portion merging smoothly into said first portion and extending radially outwardly in the region of an end of the carrier ring remote from the air intake.

6. A brake disc according to claim 5, in which an internal passage defined by the carrier ring is closed, at the end adjacent the air intake, by means of a cap which merges smoothly into said first portion.

7. A brake disc according to any one of the preceding claims, in which the blades of the fan, and a surface on which the blades are provided, are formed directly on the friction ring or on elements of the brake disc.

8. A brake disc according to any one of the preceding claims in which the two surfaces of each blade are divergent, symmetrically of the central plane of the blade, at an acute angle in the direction towards the air intake to the fan.

9. A brake disc according to claim 4, or any one of claims 5 to 8 when appendant to claim 4, in which the blades are pivotally connected to the carrier ring.

10. A brake disc according to claim 1 and substantially as hereinbefore described with reference to any one of the embodiments illustrated in the accompanying drawings.

11. A brake disc assembly including a brake disc according to any one of the preceding claims.

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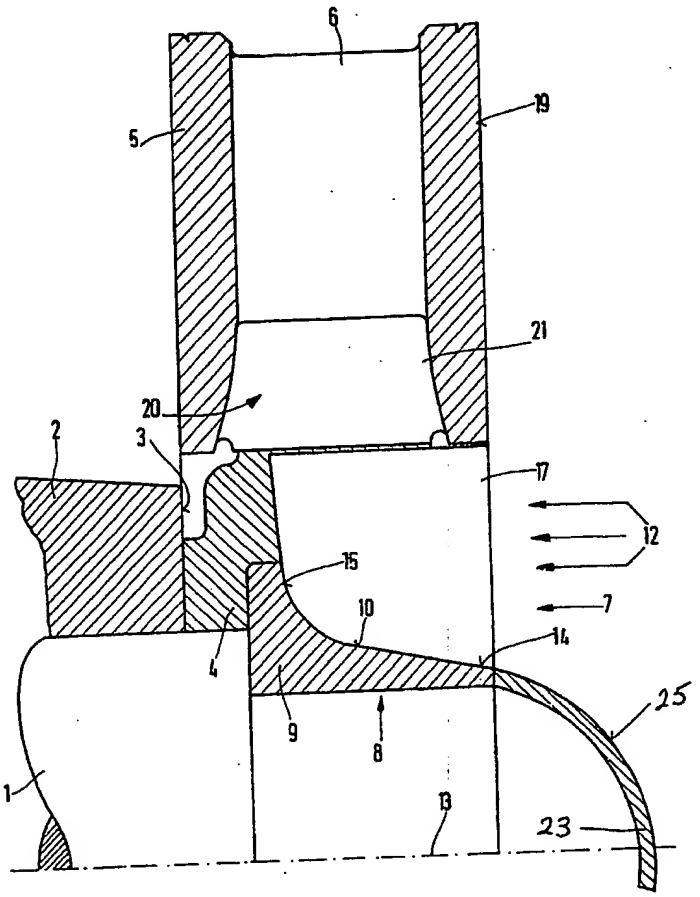
Sheet 1

FIG. 1



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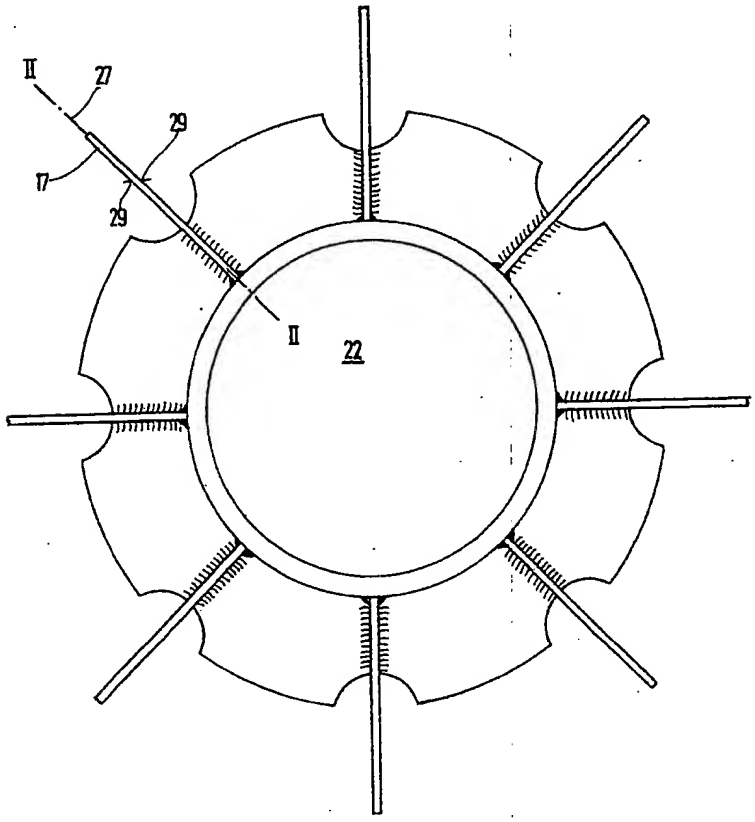
Sheet 2

FIG. 2



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Sheet 3

FIG. 3

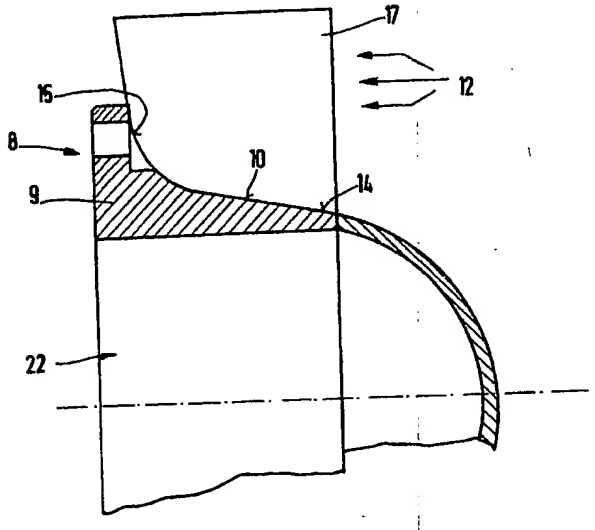

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FIG. 4

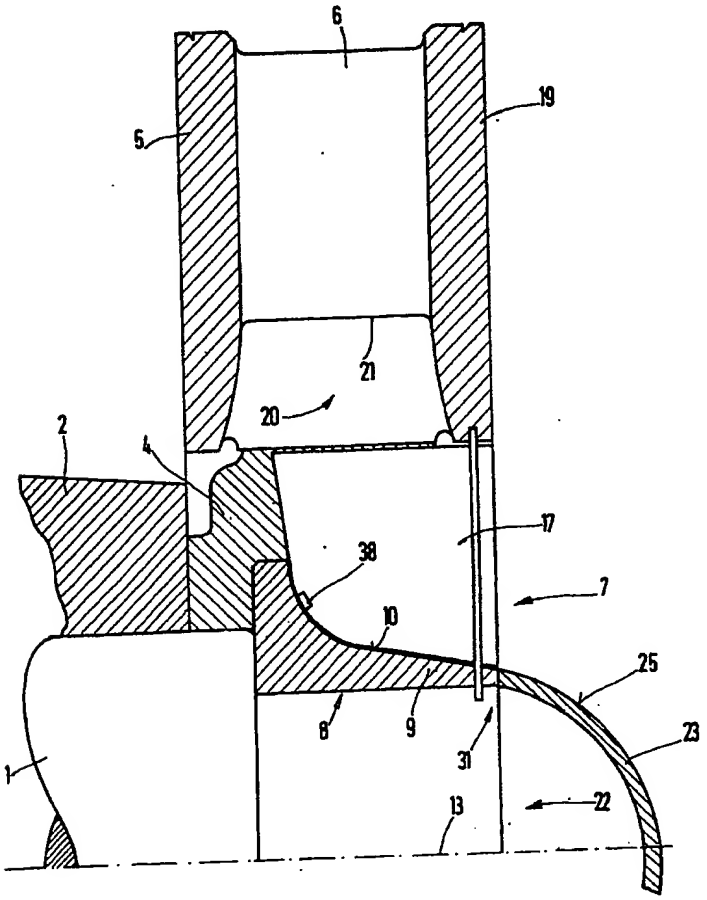

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FIG. 5